DOCUMENT RESUME

ED 231 334 IR 010 731

AUTHOR Kane, Janet H.; And Others
TITLE Microcomputer Technology in Schools: Issues for Research.
PUB DATE Apr 83
NOTE 42p.; Paper presented at the Annual Meeting of the American Educational Research Association (Montreal, Canada, April 11-14, 1983).
PUB TYPE Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Case Studies; *Computer Assisted Instruction; Computer Programs; *Curriculum Development; Educational Innovation; Elementary Secondary Education; Interviews; *Microcomputers; *Research Needs; Teacher Education; *Use Studies
IDENTIFIERS *Computer Uses in Education

ABSTRACT

This exploratory, multi-disciplinary study, which was undertaken to identify a research agenda for the educational implementation and impact of microprocessing technology, used case study methodology to explore the relationship between the social contexts and the microcomputer innovation. Three geographically distinct school districts with a diversity of microcomputer applications at both elementary and secondary levels were studied. A research team interviewed district administrators, school administrators, computer resource personnel, media specialists, teachers, students, and community members. Students were observed using microcomputers in a variety of contexts. Six trends emerged which raise questions for future research: (1) differential access to microcomputers; (2) emergence of new roles in response to microcomputers; (3) lack of integration of microcomputers into elementary classrooms and curricula; (4) inadequate quantity and quality of software; (5) inadequate preparation of teachers for using microcomputers; and (6) lack of knowledge about effects and outcomes of the instructional uses of microcomputers. A 23-item reference list and the interview guides used with schoolboard members, district administrators, teachers, and students are included. (Author/LMM)

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MICROCOMPUTER TECHNOLOGY IN SCHOOLS:

ISSUES FOR RESEARCH

Janet H. Kane
Karen Sheingold
Mari E. Endreweit

Center for Children and Technology
Bank Street College of Education
610 West 112th Street
New York, New York 10025
(212) 663-7200

Paper Presented at the Annual Meeting of the
American Educational Research Association
Montreal, April, 1983

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Abstract

This exploratory, multidisciplinary study identifies a research agenda for the educational implementation and impact of microprocessing technology.

Three geographically distinct school districts with a diversity of microcomputer applications at both elementary and secondary levels were studied. A research team interviewed people at all levels of the school system--district administrators, school administrators, computer resource personnel, media specialists, teachers, students, and community persons. Students were observed using microcomputers in a variety of contexts.

Six trends emerged which raise important questions for future research. These are: (1) differential access to microcomputers; (2) emergence of new roles in response to microcomputers; (3) lack of integration of microcomputers into elementary classrooms and curricula; (4) inadequate quantity and quality of software; (5) inadequate preparation of teachers for using microcomputers; and (6) lack of knowledge about effects and outcomes of the instructional use of microcomputers.

Microcomputer Technology In Schools: Issues For Research

Introduction

The technological developments of the past decade, which have resulted in the increasing memory capacity and decreasing cost of microprocessor chips, herald a new era of technology in education (Bell, 1979; Hakansson & Roach, 1979; Langenes, 1978; Molnar, 1975; Papert, 1980). In the recent past, schools wishing to provide computers for their students had to invest large sums of money in equipment and/or communications costs for time-sharing systems, as well as in trained personnel. These constraints resulted in computer use primarily by large educational systems willing to make a significant investment in technology, the state of Minnesota being a prime example.

With the coming of the microcomputer--inexpensive, portable, easy to use and maintain--widespread use of technology in education is now possible. An interested teacher or administrator, who only a few years ago would have had to persuade a state or city school board to make a commitment of $10,000 to $20,000 per terminal to a time-sharing system, need only persuade the PTA to donate a $1,000 microcomputer. Indeed, some PTAs initiate such a donation.

Overall, then, personal computer fits the essentially local, decentralized nature of education in the United States. Not only can local decisions be made about its purchase, but also about its use. A teacher can, at least in principle, make decisions about how to use the computer in the classroom without being dependent upon a central computing and software facility. Because the cost, portability, local control, and ease of maintenance of the microcomputer make it much more accessible to schools than were previous systems, there is an enormous potential for increasing its instructional use, scope, and personalization.

But a piece of equipment does not a revolution make. Oettinger (1969), in his thoughtful essay on computers in education in the pre-microprocessor era, concluded that there was much in the very structure of education that worked against effective innovation--a system which he characterized as rigid, yet fragmented, lacking either centralized authority or genuine flexibility. Within the classroom, Oettinger claimed, pedagogy and curriculum were unchanged by access to a computer.

While some may disagree with Oettinger's judgment or question his lack of empirical evidence, few would claim that the promise of instructional computing in the early 1960s was realized (Bunderson & Faust, 1976). And, while the new technology does differ in many important respects from the old, expectations about educational impact must be viewed cautiously. There are many steps between putting a machine, albeit a powerful and engaging machine, into a classroom and making a difference for children and teachers.

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*The work upon which this publication is based was performed pursuant to Contract No. 400-80-0023 of the National Institute of Education. It does not, however, necessarily reflect the views of that agency.

The authors wish to thank Karen Billings and Kenneth C. Laudon for their assistance with this research.

Equally as important as recent technological developments are contributions from the fields of artificial intelligence, psychology, and education which have expanded the vision of how computers might be used in the classroom. Computer-assisted instruction--well-developed, documented, and widely implemented since the early years of computers in education (Suppes & Morningstar, 1972)--puts the learner in a relatively passive stance vis-a-vis the computer and emphasizes drill and practice. New approaches, in contrast, emphasize placing the learner in an active role. Giving the child the initiative, enabling the child to take control and be the "teacher" of the computer, is thought to facilitate powerful learning in many domains (Bamberger, 1972; Bork, 1975; Dwyer, 1975; Papert, 1980).

Even though both a powerful technology and creative ideas about how it may enhance education are now available, there has been little programmatic study of the implementation of computer programs in schools or what the effects of the new technology are likely to be. While some anecdotal accounts are available, the generalizability of their conclusions is necessarily limited. The study reported here addressed this lack of knowledge. Its goal was to identify a research agenda of issues and questions that are central to understanding instructional applications of microcomputers.

The extensive sociological literature on the implementation and effects of computers in private industry, government, and the military provided a general framework for this study, (e.g., Danziger, Dutton, Kling & Kraemer, 1981; Kling, 1974; Mesthene, 1972; Mowshowitz, 1976; Pettigrew, 1973; Winner, 1977). The chief implication from this literature is that the computer does not have a simple impact on an organization or the people in it. Its implementation and use are embedded in a complex system of social and political relationships (see, especially, Danziger and Dutton, 1977; Kling, 1978; Laudon, 1974, 1977). At all levels of implementation and use, it is essential to consider the interaction of the computer with the social system that surrounds it. It is also important to understand how this interaction changes over time, as computing activities influence the social system and the social system shapes the influence of the technology. Recognition of this interactive relationship between the computer and the social system guided the design of this research.

Research Design

The basic assumption underlying the research design was that, in order to understand a technological innovation and its impact on children and teachers, it is necessary to go beyond the classroom. There are at least four contexts within which an educational innovation takes place--a community, a school system, an individual school, and a classroom. Decisions that are made, events that occur, and beliefs that are held within each context may ultimately affect the nature and scope of the impact of the computer on children and teachers in classrooms.

In order to understand the relationships between the social contexts and the microcomputer innovation, case-study methodology was used. Case studies are intensive, independent analyses of particular situations and make use of a wide variety of information sources to provide a comprehensive

description of present conditions and their history. This approach was ideally suited to the multidisciplinary, exploratory nature of this investigation. A major drawback of case studies, however, is their limited generalizability. In this research, three different case studies were included, and findings from all three were synthesized to identify issues common to all sites.

A research team composed of a sociologist, a developmental psychologist, an educational curriculum specialist, an educational researcher, and an instructional computing specialist collaboratively developed the methods and procedures for data collection. They designed interview guides and a schedule for recording their observations (see Appendix). All procedures were field tested at a pilot site.

Site selection

Three school systems were selected from a larger number of potential sites, all of which had significant microcomputer use at both the elementary and secondary level. The three were selected for the greatest diversity of geographic location, of school populations served, of goals for implementation, and of computer applications. They included a large southern city, called Salerno in this report; a large midwestern city, called Granite; and a northeastern suburban community, called Greenview.

All sites had been using microcomputers at both the elementary and secondary levels for up to two years. They had all begun time-shared instructional computing in the 1960's, and were still using terminals for some purposes. This report, however, focuses only on microcomputers and their use. The data were collected in the fall and winter of the 1980-81 school year.

Sampling within sites

At the larger sites, schools were selected that would represent the variety of applications and populations in the district, and to tap the widest possible range of information sources. In Greenview, however, because the system was small, every school using microcomputers was visited.

Data collection

A four-member team of researchers skilled in interviewing, classroom observation, and assessment of instructional applications of computing spent a week at each site. Through extensive interviews, direct observation of computer uses, and local documents about instructional computing, the team collected information on the interaction of the microcomputer and various contexts in the social system, how this interaction developed over time, and how it may develop in the future. The emphasis was on both what happened in the classrooms and the social and political contexts that influenced the classrooms.

The data collection included the four different contexts: the community, the school system, the school, and the classroom. From the broadest context, participants included parents, board of education members, local computer business people, politicians, and journalists. Within the school system, many positions were represented, including district administrators, school administrators, computer resource personnel, media specialists, teachers, and students. Interviews were semistructured and open-ended. In all, 80 teachers, 30 students, 24 school administrators, 14 district administrators, 8 technology specialists, and 10 community persons were interviewed. Observations of computer use were made in classrooms as well as in media centers, resource rooms, and after-school clubs. A total of 51 observations were made across the three case-study sites.

Salerno

Salerno provides a model for innovation in which authority and resources are centralized. Microcomputer applications were carefully planned and designed for explicit curricular goals. Microcomputer use occurred primarily outside of regular classrooms and, in this sense, was peripheral to ongoing classroom life. The unique feature of the Salerno program was its potential size and scope, represented most vividly by the large investment of district resources in software production.

Demographics

Salerno is a major southwestern city of about 800,000 in a metropolitan area of about 1.5 million. Its public school system serves 122,000 children. Insurance, banking, and technology make up a significant portion of the economy. The wealthiest residents are clustered in several prestigious suburbs, leaving a city population of primarily middle-income and low-income residents. In the last 10 to 15 years, the population around Salerno has substantially increased as part of the general Sun Belt boom. Along with the new businesses and industries, there has been a relatively large influx of non-English speaking immigrants.

By 1980, although the metropolitan area had been increasing in population, the school system itself had lost a considerable number of students (estimates ranged from 25,000 to 50,000). As a result of a bussing program, which was instituted in response to a desegregation order, many middle-class children enrolled in private schools and many families moved to the suburbs. Thus, the city school system was largely minority. In 1980-81, it had approximately 45% black, 20% hispanic, and 35% white children.

The Context for Microcomputer Applications

The highest priority of the Salerno school system in 1980-81 was raising its students' scores on state and national standardized tests. Its students had not done well nationally or in comparison with other

cities in the state. Therefore, the school system was emphasizing basic skills, and had established detailed baseline objectives in many curricular areas.

The microcomputer innovation began in Salerno as a way of enhancing the basic skills of students who were below grade level. A superintendent enthusiasiic about innovation and technology initiated local development of software. He formed an instructional design group to produce comprehensive basic skills packages providing drill and practice for students with below-average performance. This software development operation represented a large commitment of funds and resources. In 1979-80, the instructional design group employed 24 fulltime staff at a cost of almost $600,000. Of this, almost $400,000 came from district funds, and the rest came from federal monies. By 1980-81, these technology and curriculum specialists had produced a K-8 math skills package and were developing packages in reading and higher-order math skills.

The assistant to the math coordinator in the district supervised the school use of microcomputers. She assigned the equipment, was in charge of training for teachers and aides, and provided information and support to the schools as needed.

How Microcomputers Are Used

In 1980-81, the K-8 math package was used in 60 of the 180 schools in the district. Three hundred TRS-80 computers had been purchased with Title I and state compensatory education funds for this basic skills program, and 300 more were scheduled for purchase that year. Because of the source of funds, use of microcomputers was limited to those students who were below grade level.

While microcomputers were used in Salerno high schools for programming and computer literacy, at the lower grades the microcomputer was seen as an instructional tool rather than as an object of study. From kindergarten through eighth grade, the computer was used for practicing arithmetic skills previously introduced in the classroom.

In most schools, the microcomputers were located in a resource room, and students left their classrooms to work with them for 50 minutes each week. The entire computational curriculum was sequenced, and students were assigned to practice a skill at a level specified by their classroom teacher or by a Title I teacher. Aides supervised students as they worked with the computers and kept records of their progress.

The school system offered a workshop to train interested teachers and aides to use the microcomputers. At the workshop, they learned to load and run a program, how to select practice problems for students, how to keep records, and how students were to type in their responses. They also learned about the scope and sequence of the computer-based curriculum, how the different strands were organized, and how they related to the classroom curriculum. Aides and teachers reported that this training was adequate, that they felt comfortable with the microcomputer, and that they felt it was a valuable instructional tool.

Since the same baseline objectives guided the development of the software and the classroom math curriculum, there was an overall relationship between work in the classroom and in the resource centers on the microcomputers. However, since a different teacher was responsible for each situation, work on the microcomputers did not necessarily coincide temporally with related work in the classroom. A concept could be introduced in class weeks before it was practiced on the microcomputer.

Effects

What were the effects of the computer-based math practice on students in Salerno? No one knew. The teachers felt it was too soon to tell, and the school system had not yet conducted an evaluation. Clearly, the expectation was that the practice and additional time on task provided by the technology would prove effective in raising test scores.

We observed a range of involvement and enthusiasm as students worked with computers. Some students were interested and eager, others seemed bored or resistant. Since the work was done on a strictly individual basis, there was no opportunity for social interaction. Some of the students seemed challenged by what they were doing, while others seemed to need instruction in the computational procedure rather than practice with it. If children were confused, they tended to flounder or guess randomly in order to move the program along although sometimes the teacher or aide recognized and responded to the student's need for instruction.

When we examined the use of microcomputers by sex, we found more boys than girls using the microcomputers at all grade levels (in part, because of the greater representation of boys in the remedial program). The difference, however, was not large. In addition, we did not visit enough high schools to make a judgment about sex differences there.

Future Possibilities

To summarize, Salerno served as one model for using the microcomputer as a mode for delivering curriculum. Applications were carefully planned, consistent with the priorities and goals of the school system, and represented a large investment of resources. In principle, microcomputer use could affect the test performance of large numbers of children in the school system without directly changing regular classrooms.

The Salerno model, however, could dramatically change staffing patterns and instruction in the district. As indicated earlier, other large packages of software--reading and higher-order math skills--were under development. These were designed to go beyond drill and practice, taking on tutorial functions. It seemed possible that, in the future, large portions of the curriculum could be delivered via microcomputers. If so, then the aides who assisted children in operating the microcomputers and the resource teachers who supervised the delivery of computerized instruction might be responsible for introducing new concepts as well as for providing practice with previously-

taught content. Classroom teachers then would presumably become managers of instruction who focus on social skills and higher-level conceptual development with their students. The effects of such a three-tiered system (master teachers, supervisors of computer instruction, aides of computer instruction) on education can only be speculated about at this point. What is clear, however, is that in such a system the creators of software would become, to a significant degree, the creators of curriculum.

Granite

The second site, Granite, illustrates a model for innovation in which some resources and authority are centralized, but in which actual use of microcomputers and decisions about their use are decentralized. The program is loosely structured, without explicit policies or curricular goals. Because the district values diversity, it encourages schools to use microcomputers in ways compatible with their individual philosophies. Granite is unique in that it has a state organization which provides computer services.

Demographics

Granite is the center of a seven-county metropolitan area in the midwest. The city has a population of 370,000, while the greater urban area totals over 2 million. The residents are predominantly northern European, with minority populations of native Americans, blacks, and Asians. The full range of economic groups is represented in the city.

In national polls, the city of Granite is rated highly as a desirable place to live. In the immediate vicinity, there are a number of agricultural businesses, such as grain companies and food processing plants. There are also large insurance firms and high-technology companies, including major computer companies. The city is near the state capitol and also contains the major state university.

By 1980, the school system had lost large numbers of students due to a decline in the school-age population. Over the previous 12 years, the system had shrunk from 70,000 to 41,000 students--a decrease of greater than 40%. With that, the system had to decrease staff and tighten its belt. Like Salerno, Granite had been under a desegregation order. In Granite, however, there had been little movement to private schools as a result.

The Context for Microcomputer Applications

The Granite system values diversity and provides many educational options. In 1980-81, there were eight distinct elementary programs from which parents could choose. While there were some general curricular goals for the entire system, no detailed objectives were specified. Standardized tests were used for diagnosis early in the academic year, rather than for accountability and evaluation at the end of the year.

A unique feature of the Granite system was a state organization that coordinated and facilitated instructional computing at all levels of education throughout the state. This central computing organization provided teacher training, as well as microcomputers at discount prices. In addition, it developed and evaluated software and made it available to public schools at no cost.

The microcomputer innovation began in Granite in 1979. There was both grass-roots and district interest in purchasing microcomputers even before they were available as free-standing machines. The central computing organization acted as a catalyst for the purchase of microcomputers with a decision to contract with Apple. At that point, Granite's district math specialist and central administrators decided to purchase several Apples to loan to schools on request.

At both state and city levels there was a commitment to computer literacy, broadly defined, and to equity of access to computing. But neither at the state nor the city level were there centralized policies about the use of the microcomputers. The microcomputers were seen very broadly as a resource for teachers to use as they considered appropriate.

The computers were managed by a computer resource teacher working out of the office of the district's curriculum specialist for mathematics. The computer resource teacher processed applications for machines, met teachers' requests for help with the machines or with related curriculum, and conducted workshops and other forms of teacher training.

How Microcomputers Are Used

In 1980-81 there were 80 Apple computers in the city system--40 owned by schools and purchased out of operating funds or with grant monies, and 40 "loaners" owned by the district and loaned to schools on requests from teachers. At the time of the site visit, the microcomputers were in use in 23 of the districts' 100 schools and other instructional sites.

It is difficult to summarize and characterize what we saw in Granite since uses, goals, and settings were so varied. Microcomputer applications included programming, drill and practice, simulations, and games. Teachers' goals for the instructional use of the microcomputers varied from using it as a reward when students completed an assignment, to achieving computer literacy, to enhancing logical thinking. Microcomputers provided Title I remediation for below-grade students, as well as enrichment for high achievers.

In the elementary schools we visited, microcomputers were used primarily at the intermediate grades, 4 through 6. We saw them used in media centers, hallways, resource rooms and, occasionally, in classrooms. Programming had become part of the curriculum in many schools for this upper elementary group. The least extensive use of microcomputers was in

the junior high schools. There we saw microcomputers used in an after-school programming club for eighth and ninth graders, and for Title I remediation in math and language arts. In the senior high schools, there was more extensive use of microcomputers; however, use was confined almost exclusively to classes in math and business.

The initiative for getting microcomputers into schools was taken largely by individual teachers and, in some cases, media specialists. They made requests to the computer resource teacher or wrote grant proposals. Most did their own computer-related work enthusiastically, and most stressed the need for more time to learn about using microcomputers. It was unusual, however, to find a teacher who took an active role in broadening the innovation by involving and supporting other teachers.

Effects

What were the effects on students of using the microcomputers? Teachers felt that microcomputers were making a difference to students, but few talked about learning outcomes. Teachers of programming and computer math felt that, with the microcomputers, students had a powerful problem-solving tool. Many teachers felt that motivation, interest, status among peers, and feelings of efficacy were enhanced when students worked on the machines. The microcomputer proved particularly useful for a new group of Asian immigrants who were learning to speak English. They practiced math on the microcomputers, an activity that doesn't require much English. This helped them to feel successful as learners in a new and foreign environment.

Teachers noticed and mentioned sex differences in the use of the microcomputers. Some felt that girls were more cautious at first, but ultimately could become as involved as boys. At all levels, we observed more boys than girls using the computers. At the elementary level, the male/female ratio was 1.6 to 1, while at the high school level it had increased to 3.5 to 1.

With programming offered as early as third grade, student experts were beginning to spring up. Typically male, these students sometimes assumed the role of teacher with other students, and occasionally did programming for teachers. Some of the high school experts had jobs as programmers and technicians in local computer companies and stores.

Future Possibilities

To summarize, Granite provides an example of a loosely structured innovation. Microcomputers came into schools by different routes, with different funding sources, and were used for different purposes. Most of the energy for the Granite innovation came from the grass roots, with some key resources provided centrally. There were no specific plans or policies governing the use of the microcomputers.

Granite raises questions about workable structures and policies to support microcomputer use. Many media specialists felt overwhelmed by the task of sorting through the literature on educational computing, yet they definitely wanted to keep control over how and when the computer was used at the school and classroom level.

Administrators at the district level all agreed that the system would support and expand technological innovation. One raised some important questions about the future. Is the microcomputer an instructional tool or complementary to the curriculum? What really is its educational potential, and how can we assure that its use is multicultural, interdisciplinary, and creative? If commercial people develop the software, will it be educationally sound or primarily entertaining?

With so many different things happening and on so few machines, it was difficult to detect patterns in Granite. Yet there are two that deserve mention. First, most of Granite's microcomputers were not in classrooms at the elementary level. They were in resource rooms, media centers, and hallways. Such locations may have represented a desire for equitable access to the computer, but we sensed that it was more likely to represent the genuine challenge of integrating computers into classrooms and curricula.

Second, it was clear that the computer expertise that students were developing was putting pressure on the system which it couldn't always meet. While the teachers themselves didn't seem to be spreading the innovation, students' needs for additional courses and better trained teachers may have been providing an important impetus for growth and change.

Greenview

The third site, Greenview, exemplifies a model of innovation with most authority and initiative at the grass roots level, with central administrators providing support and encouragement. There were no comprehensive policies or plans for the microcomputers. Decisions about use were decentralized. Greenview was unique in the emergence of a new role--the computer buff.

Demographics

Greenview is a northeastern suburban community of about 25,000, made up largely of business and professional persons who work in a nearby city. The socioeconomic level of the community is high. Students do well on nationally standardized tests, and almost 80% of the high school graduates go on to post-secondary education. In general, the school system is eager to keep abreast of educational innovations, and to maintain its emphasis on preparation for college and beyond. In the decade prior to 1980-81, enrollment in the Greenview public schools had declined by about 15% to 5,500 students. Declining enrollments and budgetary constraints limited new hiring.

The Context for Microcomputer Applications

The school system was moving toward greater centralization with respect to issues of curriculum, accountability, and evaluation. Administrators expected that they would soon have a detailed set of objectives for each curricular area, criterion-referenced tests keyed to these objectives, and a data-based management system to trace students' progress through the educational system.

The district was supporting a high school teacher who served as computer coordinator for the school system. Her office was at the high school and, in addition to her district wide responsibilities, she taught two computer courses and sponsored the high school computer clubs.

The most significant form of support from the district was through inservice courses. Computer-related courses, taught by local teachers, were offered frequently. In addition, the school system paid part of the tuition when teachers took computer-related courses from colleges and universities.

How Microcomputers Are Used

Microcomputers first came into Greenview schools at the initiative of the computer coordinator, with administrative approval. In the fall of 1979, one Pet computer was placed in each of the elementary schools. These were purchased out of district funds. One teacher from each elementary school was trained the summer before the Pets arrived. After that, these schools bought additional microcomputers with funds obtained through grants, parent-teacher organizations, and school operating budgets. Because all the additional microcomputers depended on teacher and parent initiative, the elementary schools varied in numbers of microcomputers.

In 1980-81, there were 37 microcomputers--34 Pets and 3 Apples--in the district, used primarily in the 7 elementary schools and 2 junior high schools. Four of the Pets were loaners, while the other 33 microcomputers belonged to the schools in which they were housed. They were used for remediation, drill and practice, reinforcement, literacy, and programming. The full range of students, including the learning disabled, had access to the microcomputers.

Software in Greenview was acquired in various ways, primarily from inexpensive sources, such as Cursor magazine and other public school systems. There was some commercially produced software, as well as some programs which were produced in the district by teachers and students. A catalogue of Greenview tapes described each program, specified grade levels, and categorized software according to Bloom's taxonomy. The software was largely drill in math and language arts, sometimes in a game format. High school students were responsible for duplicating and updating sets of tapes for each Pet.

Elementary level. At the elementary level, microcomputers were used more in the upper than in the lower grades. They circulated to classrooms on a sign-up basis. There was generally one teacher who managed the microcomputers, usually a computer buff. The buffs were very knowledgeable about microcomputers and had invested a great deal of personal time in becoming so. Beyond this, they were enthusiastic about the use of microcomputers as an educational tool and were eager to involve other teachers in this innovation. Without compensation in time or money, they taught, gave support to, and spread the word among other teachers. There were both male and female buffs, some with and some without previous computer experience. One teacher told us that it was impossible to predict who would become a buff, who would find these machines captivating. In most of the elementary schools, there was at least one additional microcomputer buff--in some cases a teacher, in others a parent.

Microcomputers were clearly part of elementary classrooms in Greenview, unlike other sites. Elementary teachers had varied goals for using the microcomputers. Some wanted children to have fun while learning, others wanted students to be comfortable with computers. Some focused on children's skill development, others on the teaching of programming and problem solving.

Even though the microcomputers were physically present, their use seemed to lack integration with the curriculum. Children were often observed doing drill and practice in areas which did not coincide with current classroom instruction. In one classroom, we observed children working on mapping skills as seat work and using related skills in a computer game. Yet, neither teacher nor students seemed aware of the connection.

The compute[illegible]ffs and special education teachers had well-articulated views of how to integrate work on the computer with other modes of learning in the classroom. For many other teachers, though, such integration was not a stated goal. Many of them were at a much more tentative stage with respect to microcomputers. They needed first to master the machine before thinking about ways of using it productively in their teaching.

Secondary level. At the secondary level, microcomputers were used primarily in the junior high schools. A computer literacy course had just been initiated for all seventh graders. The course was explicitly designed to involve teachers from non-math areas. Elective courses in programming and computer math were available to eighth and ninth graders, and there were after-school clubs. Microcomputers were used occasionally in other subject areas, including English, vocational education, and earth sciences. Special education teachers regularly incorporated microcomputers into their work with students.

In each junior high school, the microcomputers were located in the classroom of the computer teacher. When teachers in other subject areas wanted to use the microcomputers, class locations had to be switched. This process was very cumbersome and required planning far in advance of actual use.

At the high school, the two microcomputers were used for classroom demonstrations and for programming by high school students who volunteered to create software requested by elementary and junior high teachers. Students in programming classes used a PDP-11 minicomputer equipped with 14 terminals.

Effects

In general, teachers in Greenview were enthusiastic about the microcomputers. Some reported that the microcomputers had an effect on their role in classrooms, putting the children more in control of their own learning and teachers more in the role of resource persons who answered questions and shared children's discoveries. Some teachers felt that they had learned new things about their students by observing them use the microcomputers. Teachers who were computer buffs had a new relationship with their peers. They were now teachers of teachers.

Teachers in Greenview, though, complained that there was not enough time to learn how to use the microcomputers, to preview programs, and to plan for their intelligent use in classrooms. They felt there was not enough variety of software, and that available software was not conceptually challenging.

How did microcomputers make a difference for Greenview students? Students themselves were clearly enthusiastic, and initiated lunchtime and after-school computer activities. Teachers in Greenview were, on the whole reluctant to talk about cognitive or learning outcomes for students. They felt it was too soon to tell. However, many talked about effects relating to social interaction and self-esteem. Students often worked together on microcomputers in Greenview, and teachers felt that there were gains in social skills as a result. Some also reported gains in self-esteem on the part of those students who learned how to use the microcomputers and could then help others.

In Greenview, there was equivalent use of microcomputers by males and females in the elementary grades. But starting in seventh grade, males predominated by a ratio of 2.5 to 1.

Students experts played an important role in Greenview. Although schools have always had students who were outstanding in some areas, these experts were different in two respects. First, they were taking on a collegial role with teachers. They taught, helped, and worked alongside teachers, as well as with other students. Teachers were positive about this collegial relationship with their students, and didn't seem to find

it threatening. Second, these experts were putting pressure on the system, asking it to meet their needs for more knowledge and training. For example, a seventh grade computer club was learning the programming skills taught to eighth graders. What they would do the next year concerned teachers and administrators.

Future Possibilities

District administrators were committed to computer literacy as an immediate goal, but had questions about the future. They were concerned about the lack of coherence and policy. A task force of teachers and administrators had been formed to begin charting policies and goals, and to design a K-12 computer curriculum. From the administrative perspective, an innovation which had gone its own way, with individual teachers doing what they chose, needed to be made more rational and better articulated with the goals and curriculum of the system. The Greenview innovation, then, was bound to become more centralized.

In Greenview, the schools were beginning to see students who had microcomputers at home. Although there was no report of current impact, the schools were anticipating a home-school connection around the technology, and were considering selling the schools' tapes to parents.

Conclusions

Each case-study site was distinctive in its use of microcomputers. From these three different sites, it is evident that school systems assimilate microcomputers to their own goals, needs, and ways of operating. Clearly, Salerno would not have a Granite-style innovation, nor vice versa. On the other hand, each system was experiencing, or was likely to experience, changes resulting from this innovation--new staffing patterns, new roles for teachers and students, new sources of curriculum.

While each case study was the source of many specific questions and hypotheses, the three cases yielded common trends highlighting issues of critical import. These six issues are proposed as an agenda for future research, as well as a foundation for educators as they plan for microcomputers in their schools. They are:

- Differential access to microcomputers
- Emergence of new roles in response to microcomputers
- Lack of intergration of microcomputers into elementary classrooms and curricula
- Inadequate quantity and quality of software

- Inadequate preparation of teachers for using microcomputers
- Lack of knowledge about effects and outcomes of the instructional use of microcomputers

Access to Microcomputers

In all sites, there was differential access to microcomputers at both the elementary and secondary levels. At the elementary level in Salerno, the differential access was deliberate since the machines were used as part of a compensatory program to improve the performance of students below grade level. Funding sources put restrictions on who could use the machines.

What long-term outcomes might result from limiting microcomputer use in the early years of schooling to students who need remediation? Will students and teachers in grades K-8 come to regard the microcomputer as a machine only for children who are not doing well? One Salerno middle-school teacher stated that there was a stigma attached to using the microcomputers, and had refused to have any in his classroom.

The other two sites valued equity of access at the elementary level. Few machines were restricted by policy or funding to specific groups of students. However, since both sites depended largely on local initiative, there was an unequal distribution of microcomputers among schools. This gave some students greater access to computers then others, based upon the school they attended. There were no apparent systematic differences between the "have" and "have not" schools with respect to student populations. But clearly this possibility needs to be anticipated and studied. A local initiative model of innovation could unintentionally result in differential access.

At the secondary level, there was differential use based on a number of dimensions. Sex was the most obvious. Starting in seventh grade, when the microcomputers moved out of classrooms and hallways into math and business departments, there was much greater male representation among students who used the microcomputers. This is not an issue of access per se, since girls were not systematically excluded from using computers.

It is, of course, too early to tell whether those girls who learned to use microcomputers in elementary school will continue to use them in junior and high school math departments. If they do, then the microcomputer innovation may be responsible for profound changes in some sex-differentiated secondary school courses. If not, then the microcomputer may well become a part of the intimate connection between males and math which already exists in our schools.

At the secondary level, there was also differential access to computers based on ability. In Salerno, the students we observed in a high school programming course were all described as "good in math." In Greenview, microcomputers were used primarily for two groups of students--those who were skilled enough to take computer math courses, and those who were learning disabled. In Granite, there was a preponderance of elective computer math courses at the senior high school level. It would appear that if anybody is being excluded from computer use, it is the average student.

It is possible that differential access to microcomputers will disappear when they are no longer scarce commodities. On the other hand, one can imagine current trends contributing to a future in which levels of achievement determine what students are permitted to do with computers. Less able students will use computers for drill and practice, while the more able will learn to program. The educational assumptions behind such a division of applications, as well as the likely educational outcomes, need careful examination.

New Roles in Response to Microcomputers

In all of the sites, several roles emerged in response to the microcomputer. Computer buffs and student experts are of particular interest because these roles result from the computer innovation, as well as provide support for its growth.

Computer buffs. There were computer buffs in Greenview and not in the other sites. Were there unique features in the Greenview innovation which made it possible or even necessary for them to emerge? In terms of how microcomputers were used, there was great similarity between Greenview and Granite, yet only in Greenview did we see teachers who tried to spread the innovation to other teachers. It is possible that the differences in the placement of microcomputers--in media and resource centers in Granite and in classrooms in Greenview--account for this difference. It may have resulted from the greater ease with which teachers in Granite could obtain hardware or software. Or it may have been an outcome of the fact that in Granite both hardware and software were available on a temporary basis from a central source in the district, while in Greenview obtaining both depended much more on local initiative but the materials then became the permanent property of the school.

Alternatively, perhaps computer buffs emerge at a certain stage of any innovation. How long they can or will perform their supportive roles is not known. The individuals in these roles may burn out or leave the system for more lucrative positions in industry. Schools and school systems may devise ways to institutionalize these roles, as they become more essential.

Finally, it is important to determine whether the buffs are a necessary component of effective innovation. Does an innovation take hold only

when there is a certain amount of grass-roots missionary zeal, or can it be just as successful when it is centrally planned and resources are widely distributed, as in Salerno?

Student experts. Student experts were unique in their relationships with teachers. They instructed teachers in computer-related skills, worked with teachers collegially on computer-related activities, and they created something which teachers wanted--software for their classrooms. Teacher-student relationships like these are unusual in elementary and secondary schools. Yet they seem likely to expand because of the rapid growth of student expertise relative to that of teacher expertise.

It is important to know whether these new student roles will continue. Is this a temporary phenomenon which will end as teachers become more expert, or a permanent change which reflects the impact of the technology per se? What kind of impact does this new student role have on teachers? Some teachers were positive about this new development, while some were concerned lest other teachers feel threatened.

A different question is how schools make use of the wealth of student expertise they are helping to create. Will students have a central role in local software development? Will they be given more formal teaching roles in computer courses?

Finally, student experts are placing demands on school systems for more computer-related courses and more advanced offerings at increasingly lower grades. This represents a unique source of pressure for curricular change and for teacher training. If schools are unable to meet these demands it is possible that students will seek learning opportunities outside of the structure of formal education.

Integration into Elementary Classrooms and Curricula

The relationship of the microcomputer to the curriculum has emerged as one of the most complex issues of this study. A central concern throughout the research was whether the computer work was integrated with classroom curriculum. On the elementary level, computers were actually physically separated from classrooms and/or not part of the ongoing classroom work. Is bringing the microcomputer into the classroom a necessary step in integrating it with the classroom curriculum?

From the case studies, it appears that such integration is likely to take place only if classroom teachers actively work toward it. Clearly the task is not an easy one. What kind of support and knowledge do teachers need in order to integrate classroom work with microcomputer activities? Is the computer buff an essential resource for making this happen? It may not be mere coincidence that where microcomputers were located in elementary classrooms, there were also computer buffs.

The focus on the integration of the computer into the curriculum stemmed from an assumption that such integration was a measure of the impact of the microcomputer. Perhaps a better measure, and a more interesting question, is whether the microcomputer is actually changing classroom curricula and activities. In none of the sites were microcomputers intended to change or replace existing curriculum. In all cases they were to be additions to the ongoing curriculum. Either computers complemented what was going on in the classroom or they comprised an additional curriculum in and of itself (i.e., computer literacy, computer programming).

However, there were some ways in which computers were affecting the curriculum. In Salerno, the software design group was essentially writing curriculum for the district. In Granite and Greenview, it was not clear whether the computer was having an impact on the content of curriculum. What seemed to be happening, however, was that classroom organization was changing. Many teachers indicated that classroom use of microcomputers resulted in a more individualized relationship between teacher and student, and less whole-group teaching.

How the microcomputer can effectively be integrated with classroom curriculum is currently one of the pressing issues of computer use in education. It seems likely, however, that the process of integration will also be one of change. It is not merely a question of putting two matching pieces--a curriculum and a computer--together. Rather, it is one of actively molding the pieces so that they can go together.

Quantity and Quality of Software

Teachers in Granite and Greenview felt that there was not enough software in non-math areas. How much software is enough? What kind of selections do teachers need? What makes some software useful and some not? Even with a dearth of software, not all of what was available was used.

Perhaps the most critical question about software, yet the most difficult to address, is that of quality. What is good software? Teachers in Granite and Greenview said that they wanted better quality software. But, at that time, neither teachers nor developers at any site were able to state explicitly what makes good software.

What seems to be needed is a body of theory and research about software. Models of how ideas can be realized in the software medium are needed, along with research about how different types of software meet different educational goals and purposes and relate to different outcomes. Such an ambitious undertaking would require systhesizing knowledge about instruction, learning, development, perception, and media.

Preparation of Teachers for Using Microcomputers

In both Granite and Greenview, teachers felt inadequately prepared to use microcomputers in their classrooms. They felt this despite the fact that in both sites there were inservice courses, opportunities for study in nearby colleges and universities, and helpful teachers and/or computer resource personnel.

Notably, teachers did not seem to want more or different courses. What they wanted most was more time to use the machines, to develop their expertise, to review available software and plan for its use in the classroom. They also wanted time to observe their students so they could better understand their students' learning styles and assess how the use of the machines could be individualized.

What kinds of knowledge and experience do teachers require in order to use computers effectively in their classrooms? Given the variability in teacher knowledge of and interest in microcomputers, effectively individualizing teacher preparation is not a simple task. Computer buffs may be important because they can give individual help to other teachers. It is important to study what constitutes adequate preparation of teachers for different instructional purposes. One would need to investigate formal sources of learning, such as courses and workshops, as well as informal, such as contacts with computer buffs and time spent working at the machines. An important issue is whether teachers can feel comfortable with computers without any knowledge of programming. Clearly, the direction of the more involved teachers in both Granite and Greenview was to learn some programming.

Given the absence of institutional incentives for computer expertise in the sites, it is important to study the intrinsic factors which account for teachers' interest and commitment. A comparison on sites with and without formal incentives would determine whether such incentives affected extent of teacher preparation and expertise.

A significant form of support for teacher preparation is the principal (Fullan & Pomfret, 1977). In general, principals were informed about the use of microcomputers in their schools. Many of them took an active role in securing funds for purchasing hardware and software. Ways in which principals accommodate to teachers' needs for time and resources for learning about microcomputers is an important area for further study.

Effects and Outcomes

No one yet really knows what the educational or developmental consequences of using microcomputers are for children. What teachers report are primarily the social outcomes related to interaction, status, and self-esteem. That teachers in all sites made such comments clearly targets this as a rich area for study (see also Hawkins, Sheingold, Gearhart & Berger, in press). On the other hand, that no one knew what children were learning by interacting with the microcomputers targets this as a high priority for research.

Final Comments

Since this study was conducted,each of the three districts has greatly increased its use of microcomputers for instruction. In addition, many other school districts have begun to use microcomputers for instruction. Some of this activity is fueled by geunine enthusiasm for what appears to be the promise of computers for education. Some of it may be motivated by parental or community pressure, or by the wish to demonstrate the forward-looking capacities of the local system. Yet, in 1983, there is little more knowledge than there was for those pioneering districts in 1980 about what the microcomputer is good for in terms of educational outcomes, or even whether it is good, and in what ways. We need to begin acquiring such knowledge very quickly in order to help quide an innovation which is growing rapidly, even in the absence of guidance.

What is clear from our study, however, is that microcomputers on their own will not promote any particular outcomes. Their impact will depend to some extent on hardware and software development. To a much larger extent, however, the effects of microcomputers on educational practice will depend on the social and educational contexts within which they are embedded.

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APPENDIX

GUIDE:
INTERVIEW FOR MEMBERS OF THE BOARD OF EDUCATION

Name_____ Board_____

Interviewer_____

HISTORY

1. How did the instructional use of microcomputers get started in this community?

   early beginnings - individuals involved, motivations, initial intent
   diffusion
   role of state and local educational agencies
   role of public and private institutions
   role of computer hardware and software firms
   involvement of computer-skilled professionals from the community

2. What has been the role of the School Board in developing a computer program in the schools?

   oversight relationship
   budget considerations
   typical of role in innovations?
   attitudes of individual board members

USE

3. How and where are microcomputers used in the school system at the present time?

   allocation
   uses - remedial instruction
          individualized instruction
          computer literacy

CONTEXT

4. Over the last few years, what major factors have been influential in shaping school policy in this community?

   demography - populations served
                population changes -
                  size
                  minority groups
                  socio-economic status
   local employment opportunities
   goals for public education -
     diversity
   economy - in general
             specifically budget/taxes
   general attitude toward educational innovation

5. Have these factors had any impact on the allocation or use of microcomputers in the schools?

6. In the last five years, what were some of the principal issues between community groups and the schools?

   economic issues
   curriculum content
   school discipline
   pupil assignment to schools
   union negotiations
   general relationships between BOE, administration and teachers

7. Have these issues influenced the use of microcomputers in any ways?

   specify active groups or individuals

8. What have been the benefits and drawbacks of using microcomputers in the schools?

   school system
   teachers
   students

FUTURE

9. Looking to the future, how do you expect microcomputers will be used in your school system in five years?

   allocation; diffusion
   changes in education values (e.g., interest in math, science)
   role of state and local agencies
   role of hardware and software firms
   changes in authority relationships
   personnel

   tie-in with answer to #8 if appropriate

10. If you could plan for the use of microcomputers in a school system with unlimited resources, what plans would you make?

GUIDE:
INTERVIEW FOR COMMUNITY LEADERS INTERESTED IN MICROCOMPUTER POLICIES

Name_____ Organization_____

Position_____ Interviewer_____

HISTORY

1. What has been your role (or the role of your organization) in influencing the use of microcomputers in the public schools?

   early beginnings - who
     involved; goals and reasons?
   diffusion
   motivations for involvement
   role in other innovations
   special expertise?

USE

2. How and where are microcomputers used in the school system?

3. What are the benefits and drawbacks of the use of microcomputers in the schools?

   school system
   teachers
   students

CONTEXT

4. Over the last few years, what factors have been influential in shaping school policy in this community?

   demography - populations served
                population changes -
                  size
                  minority groups
                  socio-economic status
   local employment opportunities
   goals for public education -
     diversity
   economy - in general
             specifically - budget/taxes
   general attitude toward
     innovation

5. Have these factors had any impact on the allocation or use of microcomputers in the schools?

6. In the last five years, what were some of the principal issues between community groups and the schools?

   who was involved:

   issue - economic issues
           curriculum content
           school discipline
           pupil assignment to school
           budgets
           union negotiations

7. Have these issues influenced the use of computers in any ways?

   specify active groups or individuals

FUTURE

8. Looking to the future, how do you expect computers will be used in your school system in five years?

   influencing factors
   allocation, diffusion
   changes in educational values
     (e.g., interest in math, science)
   changes in authority relationships

9. If you could plan for the use of microcomputers in a school system with unlimited resources, what plans would you make?

GUIDE:
INTERVIEW FOR DISTRICT ADMINISTATORS

Name_____ District_____

Position_____ Interviewer_____

USE

1. How are microcomputers being used in your school system?

   purpose: remedial instruction
   individualized instruction
   computer literacy
   schools served
   pupils served
   subject areas

HISTORY

2. How did the program come about?

   beginnings - who involved,
   initial intent
   community support
   groups for decision making -
   formal/informal
   teacher training
   representation of
   various schools
   role of teachers in
   implementation process
   (software; hardware)
   role of state and local agencies
   role of hardware and
   software firms
   position of professional
   associations, unions
   any new personnel

3. How is the program financed?

   Initial source of funds -
   budget increase; trade
   off; extra funds

   Continuing source of funds

   Allocation of monies within program
   hardware
   software
   training

   Who are the recipients and how is
   it decided?

4. Describe the factors that influenced which schools and teachers became involved with computers and which did not.

EFFECTS

5. What are the effects of the use of microcomputers on

   a) administration
   functions
   broad educational goals
   budgets

   b) teachers
   working conditions -
   role change
   training

   c) students
   interest in particular
   disciplines
   equity
   parents' attitudes

6. How do you feel about the impact of microcomputers in your school system?

   schools
   teachers
   students

7. What are the factors in the relationship between the schools and the community which influenced the use of computers?

   general economy - budget and
   taxation in particular
   changing enrollment - numbers;
   populations served
   employment opportunities
   interest in computers

   existing conflicts -
   curriculum content
   school discipline
   assignment of pupils to schools

FUTURE

8. What do you envision as the future of microcomputers in your school system in the next five years? Describe both positive and negative possibilities and the conditions that will promote positive outcomes.

9. If you could plan for microcomputer implementation in a school system with unlimited resources, what would you do?

GUIDE:
INTERVIEW FOR SCHOOL ADMINISTRATORS

Name_____ School_____

Position_____ Interviewer_____

USE

1. How are microcomputers being used in your school?

   purpose: remedial instruction
   individualized instruction
   computer literacy
   pupils served
   subject areas

HISTORY

2. How did the program come about?

   beginnings - who involved,
   initial intent
   community support
   groups for decision making -
   formal/informal
   teacher training
   role of teachers in
   implementation process
   (software; hardware)
   role of state and local
   agencies
   role of hardware and
   software firms
   position of professional
   associations, unions
   any new personnel

3. How is the program financed?

   Initial source of funds -
   budget increase; trade
   off; extra funds

   Continuing source of funds -

   Allocation of monies within program
   hardware
   software
   training

   Who are the recipients and how is
   it decided

4. Describe the factors that influenced which teachers became involved with computers and which did not.

EFFECTS

5. What are the effects of the use of microcomputers on

   a) administration
      functions
      broad educational goals
      budgets

   b) teachers
      working conditions -
      role change
      training

   c) students
      interest in particular
      disciplines
      equity
      parents' attitudes

6. How do you feel about the impact of microcomputers in your school?

   school
   teachers
   students

7. What are the factors in the relationship between the school and the community which influence the use of computers?

   general economy - budget and
   taxation in particular
   changing enrollment - numbers;
   populations served
   employment opportunities
   interest in computers?

   existing conflicts -
   curriculum content
   school discipline
   assignment of pupils to schools

FUTURE

8. What do you envision as the future of microcomputers in your school in the next five years? Describe both positive and negative possibilities and the conditions that will promote positive outcomes.

9. If you could plan for microcomputer implementation in a school with unlimited resources, what would you do?

GUIDE:

INTERVIEW FOR TEACHERS USING MICROPROCESSORS

Teacher_____ School_____

Class_____ Grade/Level_____

Interviewer_____

USE

1. How do you use microcomputers in your classroom?

   activities
   rules governing use
   software - source and adequacy
   control over use
   relationship to rest of
     curriculum
   problems

HISTORY

2. Describe the process by which computers were introduced in this school and the factors that influenced their diffusion in the school.

   early beginnings - who? why?
   source of funds
   formal/informal groups for
     decision-making
   role of teachers in the
     implementation process
   position of professional
     associations, unions
   role of state and local
     agencies
   role of hardware and
     software firms
   any new personnel?
   community support
   administrative support

EFFECTS

3. What are the effects of using micros for instruction?

   1) students
      academic achievement
      cognitive development
      social-emotional outcomes
        (interest; motivation;
        self-concept)
      peer relationships
      individual differences
      those who benefit enormously
      those who dislike computer
      boys/girls
      low-achievers/high-achievers

   2) teacher
      relationship with students
      educational role in classroom
        (do you teach differently
        because of computers)?

      teacher as worker
        training
        incentives
        personal costs
        source of support
          resource centers
          other teachers
          other?

   3) curriculum
      goals
      content

4. What kinds of issues within the school have shaped the instructional use of microcomputers?

   Have there been problems around
     their use?
     who uses
     where placed
     discipline; security

   Has there been active opposition to
     the use of micros for instruction?
     who?
     why?

FUTURE

5. If you had unlimited resources, what would you want to happen in your classroom with microcomputers? What do you think <u>will</u> happen in the next five years?

6. If you were advising a teacher who was about to begin to use micros in the classroom, what advice would you give?

GUIDE:

INTERVIEW FOR TEACHERS WHO HAVE CHOSEN NOT TO USE MICROPROCESSORS

Teacher_____ School_____

Class_____ Grade/Level_____

Interviewer_____

1. Can you tell me about how microcomputers are presently being used in this school?

   subject matter areas
   selection of teachers
   applications
   administrative encouragement
     and support
   students reactions

2. Describe the process by which computers were introduced in this school system and the factors that influenced their diffurion in the schools.

   early beginnings - who? why?
     initial intent
   source of funds
   formal/informal groups for
     decision-making
   selection of teachers
   role of teachers in
     implementation process
   administrative support
   allocation of equipment
   community support

3. What are the benefits and drawbacks of the use of microprocessors? (source of information)

   equity
   efficiency
   quality education (define)
     has there been a change in
       the process or goals of
       education?
   remedial instruction
   individualized instruction
   computer literacy

4. What are your reasons for choosing not to use micros at this time?

   Are there circumstances under which you might want to use them?

5. Given your thoughtful opposition, if you were responsible for developing policy about the instructional use of micros, and had unlimited money and talented people, what would you do?

GUIDE:
INTERVIEW FOR STUDENTS

Student_____ School_____

Class_____ Grade/Level_____

Interviewer_____

USE

1. In what ways is the microcomputer used in your class?

   activities
   fit with the rest of the class
   monitoring of work
   is what was observed typical of its use?

2. Who uses the computer?

   number of students
   time
   equity
     boys/girls
     high-achievers/low-achievers
   do students have choices about when and how it's used?
   computer sub-culture - uses on weekends and after school

3. Do you use microcomputers in other classes or as part of your extra-cirricular activities? If so, what kinds of things do you do with the computer?

   activities
   amount of time
   required/not required

EFFECTS

4. How do you feel about working with the computer?

   motivation; persistance
   attitudes toward subject matter
   durability of hardware
   do some students dislike it? - Why?

EFFECTS

5. How is the teaching in classes with microcomputers different from the teaching in classes where computers aren't used?

   instructional goals (problem-solving; drill)
   student-student interaction (collaboration; competition)
   teacher-student relationships - authority

   do students develop software or teach others to use the equipment?

6. What have you learned through working with a microcomputer?

   academic achievement
   cognitive development - problem solving; analysis
   social/emotional development

   Are there things that you think you could learn better from a computer than from a teacher?

   Are there things that you think you could learn better from a teacher than from a computer?

   Have you learned any skills through using the computer that you use in other courses?

7. What are the advantages and disadvantages in using computers as one way of helping students learn?

Classroom Observation Observer_____

Teacher_____ School_____

Class_____ Grade/Level_____ Date/Time_____

No. of Micros_____ Type_____

Class Composition: Boys_____ Girls_____ Achievement Level_____

Ethnic Representation: B_____ H_____ C_____ A_____ Other_____

1. a) Diagram the room arrangement, indicating the placement of micros (X), students (O) and teacher (△). If the teacher circulates, indicate by placing an arrow beneath the triangle.

b) Who is using the computer?

_____part of the class

_____individual students working alone
_____small groups of students working together

_____the whole class

_____teacher/student giving demonstration
_____each student at own machine
_____small groups of students at each machine

After observing computer-related activity in a classroom for 15-20 minutes, answer the following questions. Along with each answer, provide anecdotal evidence which illustrates the basis of your answer.

2. What is the purpose of the computer-based activity?

3. What is the nature of the computer-based activity?

_____simulation
_____drill and practice
_____tutorial
_____games
_____programming
_____diagnostic/prescriptive
_____testing
_____computer literacy

4. How many students were directly working with computers (indicate sex, judged ethnicity, judged achievement level.

early in class period	middle of class period	end of class period

5. In which ways is the computer-based activity individualized for students?

_____individualized courseware
_____difficulty level
_____pacing
_____self-initiated projects

6. What is the major role of the teacher?

_____presenting information
_____eliciting information
_____responding to students' questions
_____encouraging reasoning and problem solving
_____managing machine use

7. How does the teacher direct/support the students' work with the computer?

8. a) Do students work together or independently on the computer-related work? Do they have a choice about working together or independently?

b) If they are working together, are the interactions positive or negative?

9. How do students seem to feel about working with computers?

enthusiastic interested accepting bored frustrated resistant

10. How does the teacher seem to feel about working with computers?

enthusiastic interested accepting bored frustrated resistant

11. Is the computer work related to other curricular activities? How?

12. Are there any observable hardware, software, or use problems?

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